

Observations of Agonistic Behavior between Two Island Kelpfish, *Alloclinus holderi* (Lauderbach, 1907) (Labrisomidae), at Anacapa Island, California.

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We describe a previously unreported agonistic behavior between two *Alloclinus holderi* (Lauderbach, 1907). *Alloclinus holderi* (family Labrisomidae) is a small, reef-dwelling fish reaching 15 cm total length (Love and Passarelli 2020). The species ranges from San Miguel Island, southern California to Isla Asuncion (27°06'N, 114°18'W), southern Baja California (Love and Passarelli 2020), Rocas Alijos (24°57.5'N, 115°45'W) (SIO 70-371), and into the Gulf of California at least as far northward as Playa Caleritas (24°21'N, 110°17'W) (González-Acosta et al. 2018), at depths between the intertidal and 91 m (Love and Passarelli 2020).

The senior author observed and documented on video agonistic behavior between two fishes living on a rocky reef located at the south end of Cat Rock, Anacapa Island (34°00'12.5"N, 119°25'21.5"W) on the morning of 16 November 2019, at a depth of 12 m. Six to 10 *A. holderi* were observed within a crevice; most of these individuals were isolated from one another at an average distance of 0.5 m. In contrast, two individuals, of approximately equal size, were very close together, where they displayed a series of repetitive behaviors consisting of rising and lowering the front of the body while mouth gaping (Fig. 1). This was followed by biting, primarily of the opponent's upper jaw (Fig. 2), although other head regions were sometimes involved. Jaw locking lasted between 3–63 secs and averaged about 20 secs. Most of the biting initiations were instigated by one individual (i.e., the one on the viewers' right in Fig. 1). The senior author observed these interactions for about 3 min. At this point, the two fish engaged in a relatively long clasp during which time the gill operculae of both individuals began to open and close more rapidly than previously 63 secs after the initiation of this clasp, the individual on the right broke off and swam away.

While this behavior has not previously been reported in this species, it is known from closely related taxa (i.e., both threat and attack behavior were described in *Chaenopsis ocellata* Poey 1865; Robins et al. 1959). In the Gulf of California both *Paraclinus sini* and *Malacoctenus hubbsi* defend territories through various forms of threat displays (Thomson et al. 2000) and shelter defense is common among the closely allied Chaenopsidae (Robins et al 1959; Thresher 1997; Hastings 2002) and Blenniidae (e.g., Losey 1968). Jaw locking seems particularly widespread, as it has been observed among the Labrisomidae (i.e., *Labrisomus cricota*; Sazima et al. 2002) and Chaenopsidae (i.e., *Acanthemblemaria crockeri* and *Emblemaria hypacanthus*; Thomson et al. 2000). In addition, the head raising behavior we observed has also been documented in some related taxa (e.g., “rearing up” in the Trypterygiidae, Wirtz 1978; “raised heads” in the labrisomid *Dialommus fuscus*, Nieder 2001). Territoriality among the Blennioidei often (although not always, Losey 1968)

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Fig. 1. Head rearing and mouth gaping.

involves the defense by males of nest sites (Hastings and Petersen 2010). While this is likely the case among *A. holderi*, this species appears to be sexually monomorphic and thus we do not know the gender of the two individuals.

Acknowledgments

We thank Giacomo Bernardi for species identification and encouragement. We also thank Jim Knowlton for being a safe dive partner and the crew of MV *Spectre* for their assistance. Phil Hastings reviewed a draft of the paper and made significant improvements.



Fig. 2. Biting down on the upper jaw of a conspecific after the mouth gaping and head rearing behavior.

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The Role of Oil and Gas Conductors as Fish Habitat at Two Southern California Offshore Platforms

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Abstract.—Worldwide, all oil and gas offshore platforms contain conductors, a series of closely spaced vertical pipes, that carry oil and gas from the wells. During decommissioning, these conductors are usually removed. However, worldwide, there has been no research on the relationship between conductor arrays and fish densities. During summer and fall of 2017 and 2018, at Platforms Holly and A, in the Santa Barbara Channel, California, we conducted visual scuba surveys of the fish densities associated with 1) conductors, 2) crossbeams, and 3) blue (open) water under these platforms. A minimum of 14 species were observed at Platform Holly and 14 species at Platform A. Substantially more fishes, and higher densities, were observed at Holly (17,533, 636 per 100 m⁻², respectively) than at A (1,185, 171 per 100 m²). Although there were similarities, the dominant species at the two platforms were distinct. Rockfishes (genus *Sebastes*), particularly *Sebastes hopkinsi*, dominated the Holly assemblage, while the damselfish, *Chromis punctipinnis*, was the most abundant at A. Overall, at both platforms, there was no statistical difference between fish densities at conductors and at crossbeams and fish densities were higher at both conductors and crossbeams when compared to those in blue water. The species assemblage among three habitats were similar, although there were two survey occasions where no fish were observed in blue water. Our research strongly suggests that, to the extent possible, retaining conductors during partial removal will likely have a positive influence on both fish diversity and fish abundance, during at least some years.

There are 27 oil and gas platforms off the coast of California (Fig. 1). The frame of each platform, composed of vertical legs and horizontal crossbeams, is termed the jacket. These crossbeams run horizontally around the perimeter of the jacket and link the legs; they also run across the interior of the jacket and at an angle from one level to another. The jackets of all California platforms are fabricated of steel and, underwater, the architecture of these jackets is similar among almost all platforms. In addition to crossbeams and vertical legs, platforms throughout the world have a series of closely spaced vertical pipes, called conductors that carry the oil and gas to the surface (Fig. 2).

Oil and gas platforms have a finite economic life and, when a platform is no longer economical to operate, the ultimate disposition of a platform is termed *decommissioning*. Decommissioning may take a number of forms. One widely used option is “complete removal,” where the jacket, deck, and conductors are removed and miscellaneous debris from the ocean floor is collected, in an effort to return the site to pre-production conditions. However, a platform may also be “reefed.” Reefing a platform involves leaving some of the jacket in the water and options include “tow-and-place,” “topple-in-place,” and “partial

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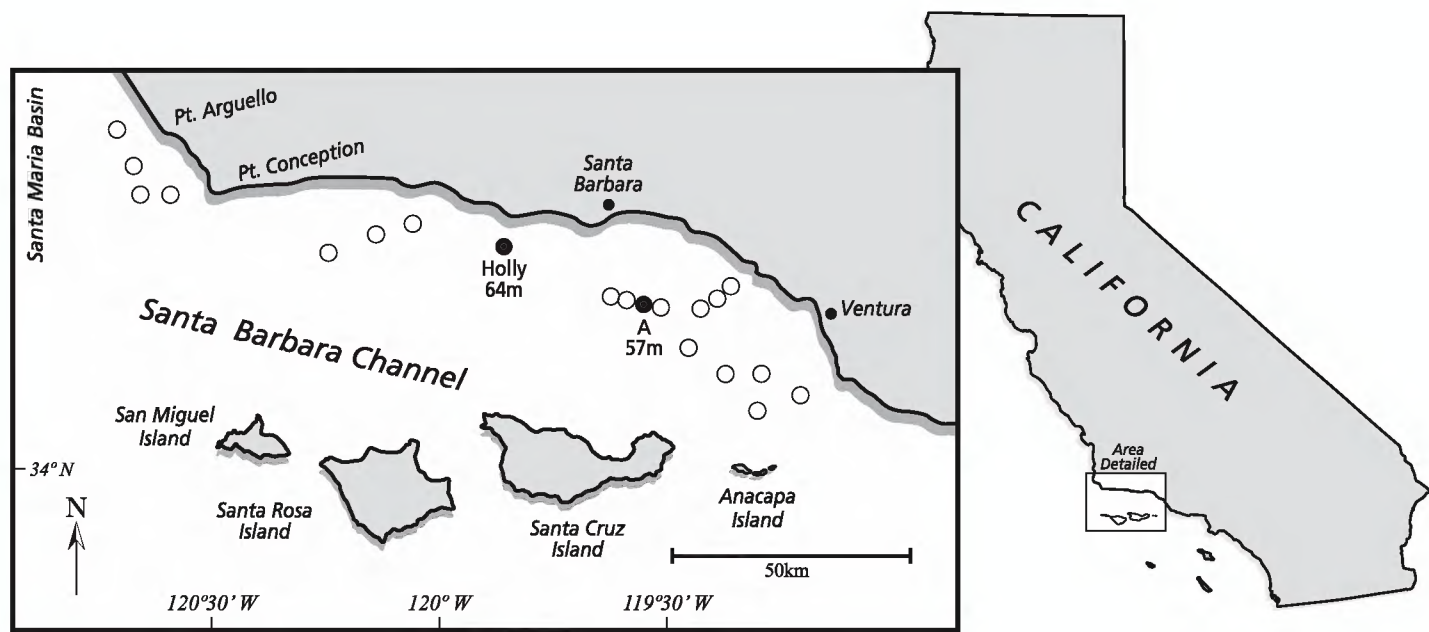


Fig. 1. Location of the 27 oil and gas platforms off California. Platforms Holly and A are denoted by closed circles.

removal” (cutting the jacket off below the sea surface; Bull and Love 2019). While platforms have never been reefed off California if, in the future, this does occur it will involve partial removal. Importantly, in the past, reefing platforms (in the Gulf of Mexico) has most often included totally removing the conductors (Bull and Love 2019).

Off California, extensive research has shown that a diverse array of reef-oriented fishes associate with both platform crossbeams and pilings (Martin and Lowe 2010; Love et al. 2015; Love et al. 2019; Meyer-Gutbrod et al. 2019). These taxa include not only adult and subadult fishes but also, in some years, very high densities of young-of-the-year (YOY) fishes, primarily rockfishes (genus *Sebastes*) (Love et al. 2019; Meyer-Gutbrod et al. 2019; Nishimoto et al. 2019). Off California, fish densities around jackets are not homogeneous; in waters down to at least 30 m interior crossbeams harbor higher densities of fishes than



Fig. 2. Vertical conductors and horizontal crossbeam at Platform A, Santa Barbara Channel, California. Photograph by Desmond Ho.

Table 1. A synopsis of platforms Holly and A (Love et al. 2019).

A	
Original operator	Union Oil
Current operator of record	DCOR
Location	34°19'N, 119°36'W
Distance from shore	9.3 km (5.8 mi) (OCS)
Water depth	57 m (188 ft)
Date installed	1968, first production: 1969
Number of well slots	57; number of conductors: 55
Produces	oil and gas
Platform jacket dimensions	40 × 48 m (133 × 158 ft) (bottom); platform footprint (1,890 m ²); platform midwater surface area: 20,996 m ²
Total removal weight (pounds, tons):	4,896
Shell mound	size (ft) 140 × 260; volume (yds ³) 7,260; height (ft) 20; center location: centered; bottom slope (%) 1.02
Holly	
Original operator	Atlantic Richfield
Current operator of record	quitclaimed by Venoco to the California State Lands Commission
Location	34°22'N, 119°52'W
Distance from shore	2.9 km (1.8 mi) (state)
Water depth	60 m (197 ft)
Date installed	1966; first production: 1966
Number of well slots:	30
Produces	oil and gas
Platform jacket dimensions:	18 × 30 m (60 × 100 ft) (surface); platform jacket dimensions: 36 × 48 m (119 × 158 ft) (bottom); platform footprint (1,728 m ²)
Shell mound size	unknown

do either vertical pilings or exterior crossbeams (Meyer-Gutbrod et al. 2019). However, as Meyer-Gutbrod et al. (2019) specifically note “One of the challenges of comparing the environmental costs and benefits of these decisions [referring to platform decommissioning] is assessing the artificial reef function of the individual existing platforms. Such assessments should consider the value of particular structural elements of these artificial reefs as potentially distinct habitats for fish.”

However, worldwide, there has been no research on the relationship between conductor arrays and fish densities. Thus, we believed that a data gap existed that prevented a more complete understanding of the role that conductors might play as fish habitat. This research was designed to compare fish assemblages and densities around conductors with those associated with other jacket elements and with the open water under platforms.

Materials and Methods

Visual surveys of fishes were performed on SCUBA within the array of conductors at two platforms, A and Holly, in the Santa Barbara Channel. We note that when the study was conducted, Platform A was still in operation and Platform Holly was not. A synopsis of each platform is found in Table 1. Platform Holly was sampled monthly for five months, June through October of 2017. Platform A was sampled monthly for six months, May through October of 2018. At each of five depths (6, 12, 18, 24, and 30 m), divers recorded both the abundance and total length of each fish encountered during a 2-meter wide, 2-meter high transect. Transect length was determined by the length of the array

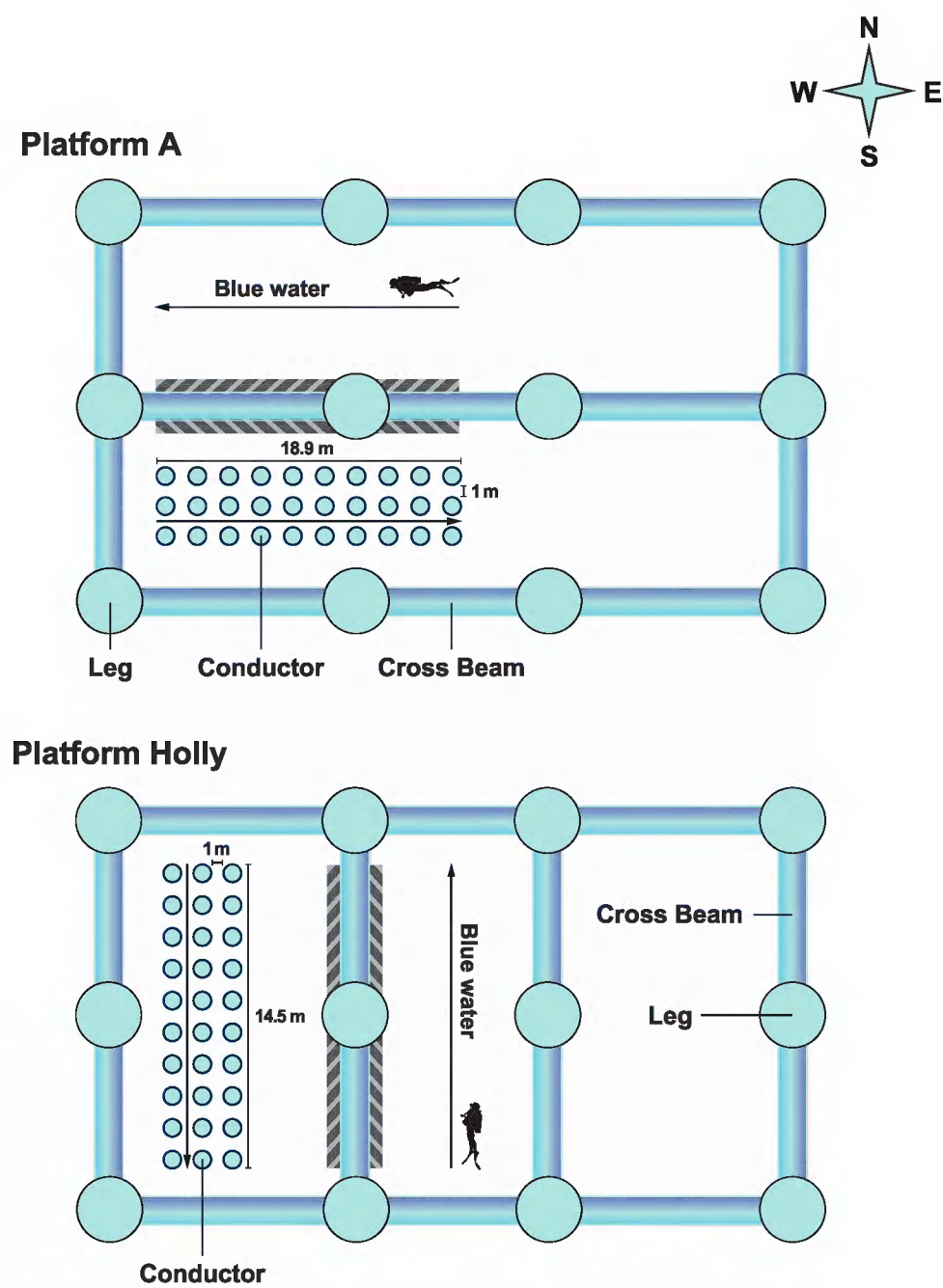


Fig. 3. Scuba protocol comparing 1) conductor and 2) blue water surveys at Platforms A and Holly, Santa Barbara Channel, California. View is based on looking downwards at the platform.

of conductors, which varied between platforms (Fig. 3). Divers swam between the vertical conductor pipes along the array’s longest dimension. At each sampling depth, divers also conducted a “blue-water” fish survey through an equivalent volume of water that was devoid of structure (Fig. 3). On the same day as the conductor and blue-water surveys, a similar survey was conducted on the crossbeams of each platform in the same depths (Fig. 3). A description of this survey method is found in Meyer-Gutbrod et al. (2019). In this analysis, we analyzed data from the interior part of the crossbeam, referable to segment HZM in Meyer-Gutbrod et al. (2019). All divers engaged in visual surveys were thoroughly trained in fish species identification and size estimation. The characterizations of fishes as young-of-the-year (YOY) were based on parameters in Love (2011).

We identified fish taxa to the lowest taxonomic level possible. Due to the challenges regarding distinguishing some fish species at their young-of-year stage, these unidentified young-of-year fish were grouped as one species in the analysis. Therefore, the term “species” refers not only to single species but also to species aggregates in some cases. Pelagic fishes were removed from the analysis because we do not expect this fish group to be intimately associated with the platform habitat. Species density was calculated as the

number of individuals for a given species or species group on a given transect divided by the length of the transect. To better visualize the density values, we multiplied the density by 100 to obtain density in the unit of number per 100 m².

We examined the effect of habitats (conductor, crossbeam, and blue water) on fish density at both platforms. To account for seasonal variation on fish density, we selected the months that fish surveys were conducted at both platforms, which were from June to October. We first examined the overall effects of habitats on fish density at each platform, and then tested the effects of three habitats on the density of the six most common species observed on each of the platforms. Because fish density data did not meet normality assumptions, and the density of individual species at each platform across all survey events were skewed with many 0s, we conducted the Kruskal-Wallis rank sum test followed by the Dunn post hoc test ($\alpha = 0.05$).

To examine the difference in the species assemblages among habitats, we constructed a Bray-Curtis dissimilarity matrix for species-specific fish densities of the top six abundant species that consisted of 98% of all fish observed. The nonmetric multidimensional scaling (NMDS) analysis was performed using monotone regression convergent solution (metaMDS in R vegan package). To test the effects of habitat on species assemblage, the Analysis of Dissimilarity (ANOSIM) with 999 permutations were used (anosim in R vegan package). Finally, we conducted a similarity percentage analysis to determine the contribution of each species to the average overall Bray-Curtis dissimilarity (simper in R vegan package). All analyses were performed using functions in R (R Core Team 2019).

Results

A minimum of 14 species were observed at Platform Holly and 14 species at Platform A (Table 2). Substantially more fishes, and higher densities, were observed at Holly (17,533, 636 per 100 m², respectively) than at A (1,185, 30 per 100 m²). Although there were similarities, the species present/absence and their dominance at the two platforms were distinct (Table 2). Rockfishes (genus *Sebastes*), particularly *Sebastes hopkinsi*, dominated the Holly assemblage (Table 1), while the damselfish, *Chromis punctipinnis*, was the most abundant at A. Of the most important species or species groups, all *S. hopkinsi*, and most *S. flavidus/serranoides*, *S. paucispinis* (in addition to “all unidentified KGB YOY”) were YOYs (Table 2). By comparison, all *Bodianus pulcher*, *Damalichthys vacca*, *Hypsypops rubicundus*, and *Paralabrax clathratus*, and a majority of *S. mystinus* and *C. punctipinnis* were either older juveniles or adults (Table 2).

The nMDS plot (Fig. 4) presents the species assemblages of the three habitats: conductor, cross beam, and blue water. The resulting stress value of 0.05 indicated that the reduced dimensions used here were a good representation of the original community assemblage. There were two survey events during which the blue water habit had zero fish counts across all water depths. In the remaining surveys that fish were observed, there was no significant difference in species assemblage among three habitats (ANOSIM statistic $R = 0.09$ and $P = 0.08$). Among the top six abundant species, over 74% of the variation in the community structure was explained by *S. hopkinsi* and *C. punctipinnis*.

Overall, at both platforms, fish densities were not significantly different between conductors and crossbeams (Table 3) and fish densities were higher at both conductors and crossbeams when compared to those in blue waters (Table 3, Fig. 5). At Holly, *S. mystinus* were more abundant around the conductors than at the crossbeams; by contrast unidentified KGB YOYs were absent from the conductors and, in fact, only present around the

Table 2. Numbers and densities of all fish taxa observed at all platform habitats and depths at two platforms in the Santa Barbara Channel, southern California. Surveys at Platform Holly were conducted in 2017 and those at Platform A in 2018. Densities are in fish per 100 m². YOY = young-of-the-year.

Species	Holly		A		% YOY
	Number	Density	Number	Density	
<i>Sebastes hopkinsi</i>	16,131	576.9	66	1.5	100.0
<i>Sebastes flavidus/serranoides</i>	381	16.9	0	0	99.7
<i>Sebastes mystinus</i>	364	16.4	158	3.8	47.1
<i>Sebastes paucispinis</i>	325	12.9	0	0	97.5
Unidentified KGB YOY ¹	164	5.7	3	<0.1	100.0
<i>Chromis punctipinnis</i>	112	5.0	618	15.8	26.0
<i>Phanerodon atripes</i>	29	1.3	11	0.2	0.0
<i>Oxylebius pictus</i>	9	0.3	21	0.5	76.7
<i>Sebastes serranoides</i>	4	0.2	0	0	0.0
<i>Sebastes caurinus</i>	3	0.1	0	0	66.7
<i>Hexagrammos decagrammus</i>	3	0.1	0	0	100.0
<i>Medialuna californiensis</i>	2	0.1	15	0.4	0.0
<i>Sebastes dallii</i>	3	0.1	6	0.1	100.0
<i>Sebastes rastrelliger</i>	1	<0.1	0	0	100.0
<i>Scorpaenichthys marmoratus</i>	1	<0.1	1	<0.1	50.0
<i>Sebastes rubrivinctus</i>	1	<0.1	0	0	100.0
<i>Damalichthys vacca</i>	0	0	57	1.4	1.8
<i>Girella nigricans</i>	0	0	1	<0.1	0.0
<i>Hypsypops rubicundus</i>	0	0	35	0.8	0.0
<i>Oxyjulis californica</i>	0	0	5	0.1	0.0
<i>Paralabrax clathratus</i>	0	0	91	2.6	0.0
<i>Sebastes atrovirens</i>	0	0	4	0.1	0.0
<i>Bodianus pulcher</i>	0	0	94	2.6	0.0
Total Number	17,533	636	1,186	30	94

¹ May be young-of-the-year *Sebastes atrovirens*, *Sebastes carnatus*, *Sebastes caurinus*, or *Sebastes chrysomelas*.

Table 3. The table shows the fish count and density for each habitat type at two platforms, and the comparison among conductors, crossbeams, and open water. The values presented in the Number and Density columns are the count and density of all species, specifically, the median (of the average fish count/density across water depths in a survey event) and the minimum – maximum ranges across all survey events. The comparison is based on the Kruskal-Wallis Test followed by the Dunn post hoc test of the fish densities among conductors, crossbeams, and blue water at two platforms, Holly and A, in the Santa Barbara Channel. The Z test statistics and p value adjusted with the Benjamini-Hochberg method are provided. *0.01 < P < 0.05 ** P < 0.01.

	Platform Holly		Platform A	
	Number	Density	Number	Density
Conductor	72 (1-1716)	248 (3-5917)	9 (8-18.8)	26 (22-50)
Crossbeam	60(3-1245)	150 (10-2660)	28 (9-48)	45 (14-88)
Blue water	0.3 (0-16)	0.9 (0-56)	2 (1-8)	6 (2-21)
Comparison	Z	Padj	Z	Padj
Conductor - Crossbeam	0.286	0.774	-0.266	0.790
Conductor - Blue water	3.167	0.002**	2.325	0.030*
Cross beam - Blue water	2.646	0.008**	2.694	0.021*

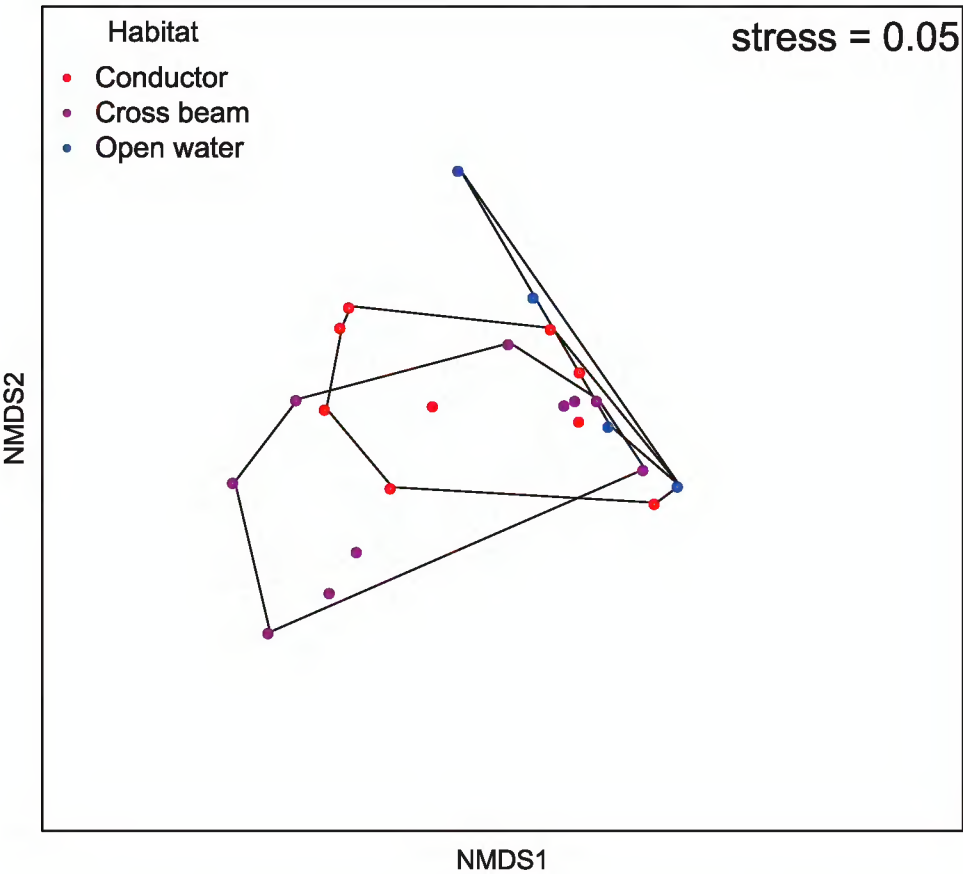


Fig. 4. A non-metric multidimensional scaling (NMDS) analysis of the top six most abundant species among three habitats at Platforms Holly and A in the Santa Barbara Channel. The six species are: *S. hopkinsi*, *C. punctipinnis*, *S. mystinus*, *S. flavidus/serranoides*, *S. paucispinis*, and unidentified KGB YOY, representing 98% of all fishes observed. Each point in the figure represents a habitat type at a platform for a given survey event. The species density is the mean density across all water depths.

crossbeams. *S. hopkinsi*, *S. flavidus/serranoides*, *S. mystinus*, and *S. paucispinis* were more abundant at conductors than in blue water, and *S. hopkinsi* was more abundant at crossbeams than in blue water. At A, only *B. pulcher* exhibited statistically significant density differences among habitats, it was less abundant in blue water compared to both conductors and crossbeams (Table 4). In no instance was a species most abundant in blue water.

Discussion and Conclusions

The fish assemblages documented at Platforms Holly (2017) and A (2018) were similar to assemblages we have documented in other studies (Nishimoto and Love 2011; Love et al. 2015; Meyer-Gutbrod et al. 2019). Overall, rockfishes, primarily YOYs, of a number of species and *C. punctipinnis* dominated, and a number of other reef-associated species (i.e., *B. pulcher*, *P. clathratus*, and *D. vacca*) were also important. However, there were differences in density and dominant species between the two platforms. In particular, Platform A harbored much lower densities of most rockfish species or species groups, particularly of the YOY stages. Similarly, a number of reef species important at A (i.e., *B. pulcher*, *P. clathratus*, and *D. vacca*) were absent from Holly.

This inter-platform variability was to be expected, as our previous research has shown that although there is a “typical” suite of species occupying California platform shallow waters, there is high interannual variability at any single platform. And while this is true of any taxa, it is particularly the case with the YOY stages and is reflective of mutable inter-annual oceanographic conditions. For instance, at Platform A, in 2012 and 2013, densities of YOY rockfish species that were not abundant in our current study at times dominated the assemblage. As examples, at Platform A *S. hopkinsi* varied between 15.6 m⁻² (2012)

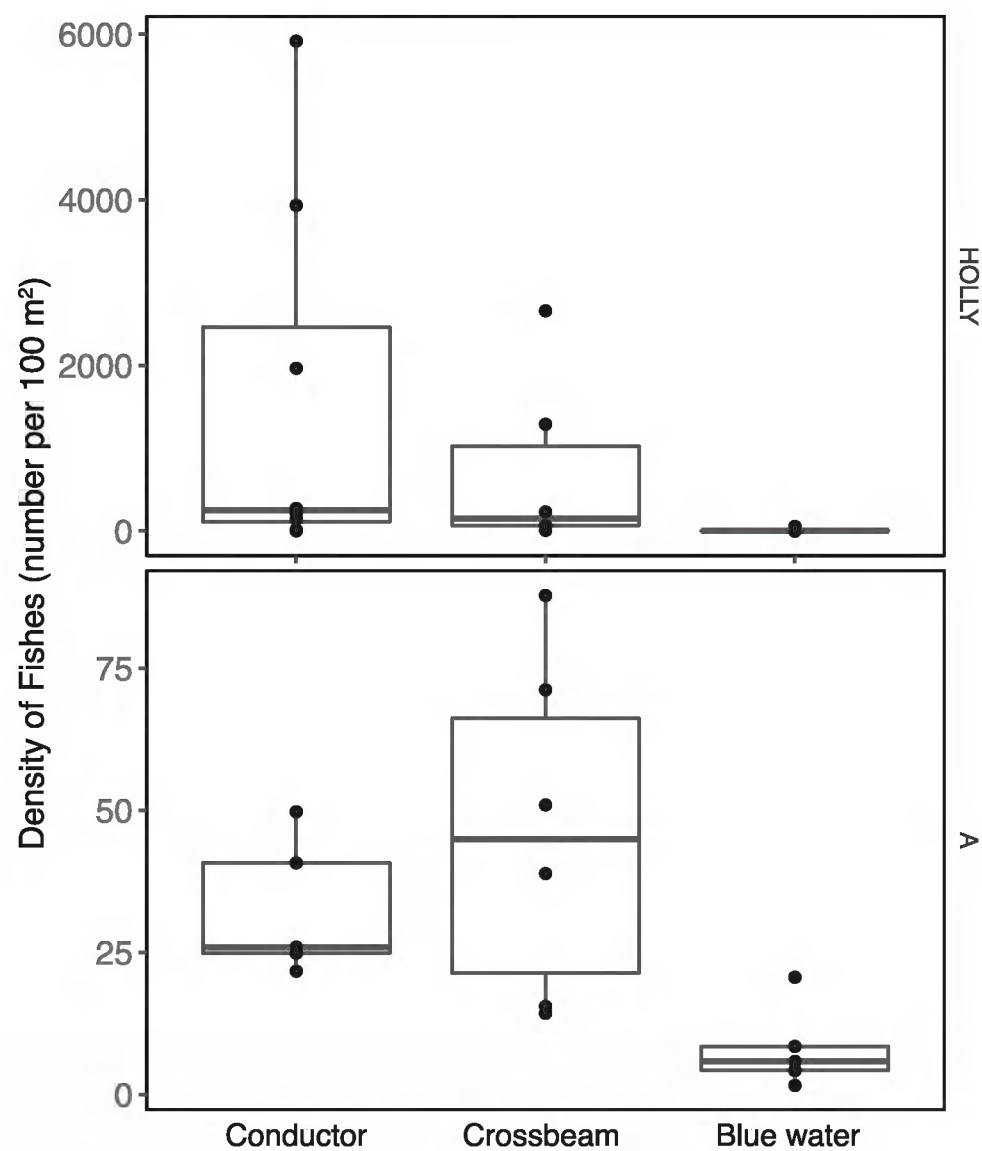


Fig. 5. Boxplot (median, 25%, and 75% quantile) of fish densities at Platforms Holly and A at three habitats: conductors, crossbeams, and blue water. The points in the boxplot are the mean average all-fish density across water depths for a survey event.

and 393.1 m⁻² (2013), *S. mystinus* 1.1 m⁻² and 294.0 m⁻², respectively, and *S. paucispinis* 0.4 m⁻² and 31.6 m⁻², respectively. On the other hand, *C. punctipinnis*, the most abundant species at Platform A in our study, was not abundant in either 2012 or 2013 (1.9 m⁻² and 23.8 m⁻², respectively) (Love et al. 2015).

Across all taxa combined, connectors and crossbeams harbored higher densities of fishes than did the blue-water habitat and these densities were not significantly different between conductors and crossbeams. One of the reasons this might be expected was that most of these fishes were YOYs and this stage, particularly prone to predation, uses structure as a refuge from predators. At the species level, and almost without exception, densities of all of the major taxa were higher around the structures than in the blue water. However, the high variability and low numbers of fish counts particularly at Platform A, created low power in statistical comparisons, and made it difficult to discern how these taxa relate to the three habitats. Low abundances of most fishes notwithstanding, it is likely that some species do exhibit a preference between conductors and crossbeams, as was the case with both *S. mystinus* and unidentified KGB YOY at Holly.

This study found that conductors are valuable fish habitat for many platform fish species. What implications do the results of this study have for decommissioning? There are several pathways for retention of conductors under partial removal. At the federal level, the Bureau of Ocean Energy Management (BOEM) has adopted a policy on a case-by-case

Table 4. Density differences of the top six species between three habitats at Platforms Holly and A. The species are ordered from highest to lowest density. Con = Conductor, CB = Crossbeam, and BW = Blue Water. YOY = young-of-the-year. The values listed in the table are Z statistical results from the Kruskal-Wallis rank sum test followed by the Dunn post hoc test, to determine the density difference among three habitats for the top six dominant species at each platform. As an example, a positive value in the “Con-CB” column indicates that the conductor has a greater species density compared to the crossbeam. The asterisks characterize the significance levels.

Platform Holly			
Species	Con-CB	Con-BW	CB-BW
<i>Sebastes hopkinsi</i>	− 0.183	3.614**	4.000**
<i>Sebastes flavidus/serranoides</i>	1.718	3.317*	1.785
<i>Sebastes mystinus</i>	3.106**	2.279*	− 0.699
<i>Sebastes paucispinis</i>	0.521	2.385	1.998
Unident. KGB ¹ YOY	− 3.388**	0.0	3.388**
<i>Chromis punctipinnis</i>	1.358	1.548	0.278
Platform A			
Species	Con-CB	Con-BW	CB-BW
<i>Chromis punctipinnis</i>	0.305	1.527	1.289
<i>Sebastes mystinus</i>	0.310	1.647	1.412
<i>Paralabrax clathratus</i>	2.101	2.248	0.247
<i>Bodianus pulcher</i>	1.472	3.710**	2.403*
<i>Sebastes hopkinsi</i>	0.163	1.257	1.150
<i>Damalichthys vacca</i>	0.076	0.312	0.250

* 0.01 < P < 0.05

** P < 0.01

¹ May be young-of-the-year *Sebastes atrovirens*, *Sebastes carnatus*, *Sebastes caurinus*, or *Sebastes chrysomelas*.

basis that “allows for the retention of the conductor pipes, at the same cut depth (usually — 26 m) at which industry proposed to cut the platform jacket for partial removal when converting a decommissioned platform into a reef (Bull and Love 2019),” while the California Marine Resources Legacy Act provides that “California will consider only partial removal for reefing done by severing the platform jacket and conductors at about 26 m below the sea surface (Bull and Love 2019).” Unlike at many Gulf of Mexico platforms, where fish densities peak in relatively shallow waters, off California YOY midwater densities remain relatively high down to depths of 150 m and densities of older fishes remain high to 200 m or more (Love et al. 2019). Thus, even if the conductors are severed to about 26 m, our research strongly suggests that, to the extent possible, retaining conductors during partial removal will likely have a positive influence on both fish diversity and fish abundance, during at least some years.

Acknowledgements

This research was supported by the National Aeronautics and Space Administration Biodiversity and Ecological Forecasting program (NASA Grant NNX14AR62A), the Bureau of Ocean and Energy Management Ecosystem Studies program (BOEM Award MC15AC00006), University of Southern California Sea Grant, and NOAA in support of the Santa Barbara Channel Biodiversity Observation Network.

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